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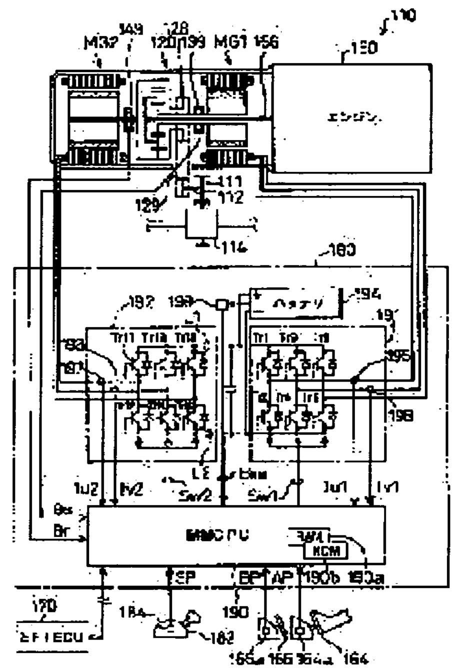
(54) POWER OUTPUTTING DEVICE AND ITS CONTROL METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To stably output desired power to a driving shaft even in a transient time when the operating state of an engine is changed.
SOLUTION: A power outputting device 110 is provided with a planetary gear 120, an engine 150 with its crank shaft 156 connected to the planetary gear 120, a motor MG1 mounted on a sun gear and a motor MG2 mounted on a starter gear. When the operating point of the engine 150 is changed by pressing on an acceleration pedal 164, the acceleration of the angle of rotation of the sun gear is obtained. This is multiplied by the moment of inertia viewed from the motor MG1 of the inertial system comprising the motor MG1 and the engine 150 to calculate torque used when changing the operating point of the engine 150 and to drive the motor MG2 considering this torque. As a result, this makes it possible to output desired torque even in a transient time.



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CLAIMS

[Claim(s)]

[Claim 1] The prime mover which is the power output unit which outputs power to a driving shaft, and has an output shaft, The 1st motor which has a revolving shaft, and outputs and inputs power to this revolving shaft, and the 2nd motor which output and input power to said driving shaft, When it has three shafts respectively combined with said driving shaft, said output shaft, and said revolving shaft and power is outputted and inputted among these three shafts to any 2 shafts, A 3 shaft type power I/O means to output and input the power which becomes settled based on the this power outputted and inputted to one residual shaft, The charge and discharge of the power used for I/O of the power by said 1st motor, The accumulation-of-electricity means in which the charge and discharge of the power used for I/O of the power by said 2nd motor are possible, A target power setting means to set up the target power which should be outputted to said driving shaft, and an operational status setting means to set up the operational status of said prime mover based on the this set-up target power, The operation control means which controls this prime mover and said 1st motor so that said prime mover is operated by the set-up this operational status, A power operation means to calculate the power outputted and inputted by said driving shaft through 3 shaft type power I/O means with said control of the prime mover by this operation control means, and said 1st motor, A power output unit equipped with the motor control means which controls said 2nd motor so that this target power is outputted to said driving shaft based on the calculated this power and said target power.

[Claim 2] Said power operation means is a power output unit according to claim 1 which is a means to calculate based on the rate of change of the rotational speed of the output shaft of said prime mover.

[Claim 3] Said power operation means is a power output unit according to claim 1 which is a means to calculate based on the rate of change of the rotational speed of the revolving shaft of said 1st motor.

[Claim 4] There is no claim 1 which is a means to set up the operational status of this prime mover so that the power equivalent to said target power may be outputted from said prime mover, and said operational status setting means is the power output unit of a publication 3 either.

[Claim 5] Said operational status setting means is a power output unit according to claim 4 which is a means to set up the operational status of this prime mover so that the effectiveness of said prime mover may become high.

[Claim 6] There is no claim 1 which is a means to set up the idle state of operation as operational status of said prime mover when said target power is under a predetermined value, or when there are predetermined directions of an operator, and said operational status setting means is the power output unit of a publication 3 either.

[Claim 7] The prime mover which has an output shaft, and the 1st motor which have a revolving shaft, and output and input power to this revolving shaft, When it has three shafts respectively combined with the 2nd motor which outputs and inputs power to a driving shaft, and said driving shaft, said output shaft and said revolving shaft and power is outputted and inputted among these three shafts to any 2 shafts, A 3 shaft type power I/O means to output and input the power which becomes settled based on the this power outputted and inputted to one residual shaft, The charge and discharge of the power used for I/O of the power by said 1st motor, It has the accumulation-of-electricity means in which the charge and discharge of the power used for I/O of the power by said 2nd motor are possible. The operational status of said prime mover is set up based on the target power which is the control approach of the power output unit which outputs power to said driving shaft, and should be outputted to said driving shaft. While controlling this prime mover and said 1st motor so that said prime mover is operated by the set-up this operational status The control approach of the power output unit which calculates the power outputted and inputted by said driving shaft through 3 shaft type power I/O means with control of said prime mover and said 1st motor, and controls said 2nd motor so that this target power is outputted to said driving shaft based on the this calculated power and said target power.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the power output unit which outputs efficiently the power outputted from a prime mover to a driving shaft, and its control approach in detail about a power output unit and its control approach.
[0002]
[Description of the Prior Art] Conventionally, the thing which comes to combine the torque converter using a fluid and a change gear as a power output unit which carries out torque conversion of the power outputted from a prime mover, and is outputted to a driving shaft was used. The torque converter in this equipment transmits power between both shafts through a flow of the fluid which has been arranged and was enclosed between the revolving shafts combined with the output shaft and change gear of a prime mover. Thus, in a torque converter, in order to transmit power by flow of a fluid, slipping arises among both shafts and the energy loss according to this slipping occurs. Correctly, this energy loss is expressed with a product with the torque then delivered the rotational frequency difference of both shafts to the output shaft of power, and is consumed as heat.
[0003]
[Problem(s) to be Solved by the Invention] Therefore, by the car which carries such a power output unit as a source of power, when large power was required like [when slipping between both shafts becomes large (for example, when running the time of start and ascent inclination at a low speed)], there was a problem that the energy loss in a torque converter became large, and became what has low energy efficiency. Moreover, since the transmission efficiency of the power in a torque converter does not become 100% even if it is at the stationary transit time, for example compared with the transmission of manual system, the fuel consumption cannot but become low.
[0004] The power output unit and its control approach of this invention solve an above-mentioned problem, and set to one of the purposes to offer the equipment which outputs the power outputted from a prime mover to a driving shaft efficient, and its control approach.
[0005] In addition, in view of an above-mentioned problem, not using the torque converter using a fluid, the applicant had a prime mover, the epicyclic gear drive, the generator, the motor, and the dc-battery, and has proposed what outputs the power outputted from a motor using the power stored in the power outputted from a prime mover, or a dc-battery to a driving shaft (the Provisional-Publication-No. No. 30223 [50 to] official report). However, by this proposal, it is not clearly shown about control of a transient when the operational status made into the target of a prime mover is changed.
[0006] Then, the power output unit and its control approach of this invention set to one of the purposes to offer the equipment which is stabilized by the transient by which the operational status made into the target of a prime mover was changed, and outputs target power to a driving shaft, and its control approach.
[0007] The power output unit and its control approach of this invention took the following means, in order to solve a part of above-mentioned purpose [at least].
[0008]
[The means for solving a technical problem, and its operation and effectiveness] The prime mover which the power output unit of this invention is a power output unit which outputs power to a driving shaft, and has an output shaft, The 1st motor which has a revolving shaft, and outputs and inputs power to this revolving shaft, and the 2nd motor which output and input power to said driving shaft, When it has three shafts respectively combined with said driving shaft, said output shaft, and said revolving shaft and power is outputted and inputted among these three shafts to any 2 shafts, A 3 shaft type power I/O means to output and input the power which becomes settled based on the this power outputted and inputted to one residual shaft, The charge and discharge of the power used for I/O of the power by said 1st motor, The accumulation-of-electricity means in which the charge and discharge of the power used for I/O of the power by said 2nd motor are possible, A target power setting means to set up the target power which should be outputted to said driving shaft, and an operational status setting means to set up the operational status of said prime mover based on the this set-up target power, The operation control means which controls this prime mover and said 1st motor so that said prime mover is operated by the set-up this operational status, A power operation means to calculate the power outputted and inputted by said driving shaft through 3 shaft type power I/O means with said control of the prime mover by this operation control means, and said 1st motor, Let it be a summary to have the motor control means which controls said 2nd motor so that this target power is outputted to said driving shaft based on the calculated this power and said target power.
[0009] The power output unit of this this invention outputs and inputs the power which becomes settled based on the power with which a 3 shaft type power I/O means to have three shafts respectively combined with the driving shaft to which I/O of power is carried out by the 2nd motor, the output shaft of a prime mover, and the revolving shaft to which I/O of power is carried out by the 1st motor was outputted and inputted when power was outputted and inputted among these three shafts to any 2 shafts to one residual shaft. An accumulation-of-electricity means performs the charge and discharge of the power used for I/O of the power by the 1st motor, and the charge and discharge of the power used for I/O of the power by the 2nd motor if needed. An operational status setting means sets up the operational status of a prime mover based on the target power set up as power which should be outputted to a driving shaft with a target power setting means, and an operation control means controls a prime mover and the 1st motor so that a prime mover is operated by this set-up operational status. A power operation means calculates the power outputted and inputted by the driving shaft through 3 shaft type power I/O means with control of the prime mover by the operation control means, and the 1st motor, and a motor control means controls the 2nd motor so that target

power is outputted to a driving shaft based on this power and target power that were calculated.
[0010] According to the power output unit of such this invention, the power outputted and inputted by the driving shaft through 3 shaft type power I/O means with control of a prime mover and the 1st motor can be calculated, and the 2nd motor can be controlled so that target power is outputted to a driving shaft based on this power and target power that were calculated. For this reason, the transient immediately after changing the operational status of a prime mover can also stabilize for it and output target power to a driving shaft. Consequently, fluctuation of the power outputted to a driving shaft with modification of the operational status of a prime mover can be prevented. Torque conversion of the power outputted from a prime mover can be carried out from the first, and it can output to a driving shaft.
[0011] In the power output unit of this this invention, said power operation means shall be a means to calculate based on the rate of change of the rotational speed of the revolving shaft of said 1st motor in that said power operation means shall be a means to calculate based on the rate of change of the rotational speed of the output shaft of said prime mover ****. Thus, based on the rate of change of the rotational speed of the output shaft of a prime mover, or the rate of change of the rotational speed of the revolving shaft of the 1st motor, it can calculate because change of the operational status of a prime mover appears as rate of change of the rotational speed of the output shaft of a prime mover and it appears also as rate of change of the rotational speed of the 1st revolving shaft with 3 shaft type power I/O means.
[0012] In the power output unit of this invention, said operational status setting means shall be a means to set up the operational status of this prime mover so that the power equivalent to said target power may be outputted from said prime mover. If it carries out like this, torque conversion of the power outputted from a prime mover can be carried out, and it can output to a driving shaft. In the power output unit of this mode, said operational status setting means shall be a means to set up the operational status of this prime mover so that the effectiveness of said prime mover may become high. If it carries out like this, effectiveness of the whole equipment can be made higher.
[0013] Moreover, in the power output unit of this invention, said operational status setting means shall be a means to set up the idle state of operation as operational status of said prime mover, when said target power is under a predetermined value, or when there are predetermined directions of an operator. If it carries out like this, target power can be outputted to a driving shaft also in the case of a halt of a prime mover.
[0014] The prime mover by which the control approach of the power output unit of this invention has an output shaft, and the 1st motor which have a revolving shaft, and output and input power to this revolving shaft, When it has three shafts respectively combined with the 2nd motor which outputs and inputs power to a driving shaft, and said driving shaft, said output shaft and said revolving shaft and power is outputted and inputted among these three shafts to any 2 shafts, A 3 shaft type power I/O means to output and input the power which becomes settled based on the this power outputted and inputted to one residual shaft, The charge and discharge of the power used for I/O of the power by said 1st motor, It has the accumulation-of-electricity means in which the charge and discharge of the power used for I/O of the power by said 2nd motor are possible. The operational status of said prime mover is set up based on the target power which is the control approach of the power output unit which outputs power to said driving shaft, and should be outputted to said driving shaft. While controlling this prime mover and said 1st motor so that said prime mover is operated by the set-up this operational status The power outputted and inputted by said driving shaft through 3 shaft type power I/O means with control of said prime mover and said 1st motor is calculated, and let it be a summary to control said 2nd motor so that this target power is outputted to said driving shaft based on the this calculated power and said target power.
[0015] According to the control approach of the power output unit of this this invention, the power outputted and inputted by the driving shaft through 3 shaft type power I/O means with control of a prime mover and the 1st motor can be calculated, and the 2nd motor can be controlled so that target power is outputted to a driving shaft based on this power and target power that were calculated. For this reason, the transient immediately after changing the operational status of a prime mover can also stabilize for it and output target power to a driving shaft. Consequently, fluctuation of the power outputted to a driving shaft with modification of the operational status of a prime mover can be prevented. Torque conversion of the power outputted from a prime mover can be carried out from the first, and it can also output to a driving shaft.
[0016]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained based on an example. It is the block diagram showing the outline configuration of the car with which the block diagram in which drawing 1 shows the outline configuration of the power output unit 110 as one example of this invention, and drawing 2 incorporated the partial enlarged drawing of the power output unit 110 of an example, and drawing 3 incorporated the power output unit 110 of an example. It explains from the configuration of the whole car using drawing 3 first on account of explanation.
[0017] This car is equipped with the engine 150 which outputs power by using a gasoline as a fuel as shown in drawing 3 . This engine 150 inhales the gaseous mixture of the air inhaled through the throttle valve 166 from the inhalation-of-air system, and the gasoline injected from the fuel injection valve 151 to a combustion chamber 152, and changes into rotation of a crankshaft 156 movement of the piston 154 depressed by explosion of this gaseous mixture. Here, the closing motion drive of the throttle valve 166 is carried out by the actuator 168. An ignition plug 162 forms a spark with the high voltage drawn through the distributor 160 from the ignitor 158, and gaseous mixture is lit by the spark and carries out explosion combustion of it by it.
[0018] Operation of this engine 150 is controlled by the electronic control unit (hereafter referred to as EFIECU) 170. The various sensors in which the operational status of an engine 150 is shown are connected to EFIECU170. For example, it is the rotational frequency sensor 176, the angle-of-rotation sensor 178, etc. which are prepared for the coolant temperature sensor 174 and distributor 160 which detect the water temperature of the throttle-valve position sensor 167 which detects the opening (position) of a throttle valve 166, the inlet-pipe negative pressure sensor 172 which detects the load of an engine 150, and an engine 150, and detect the rotational frequency and angle of rotation of a crankshaft 156. In addition, although the starting switch 179 which detects the condition ST of an ignition key was connected to EFIECU170 in addition to this, illustration of other sensors, a switch, etc. was omitted.
[0019] The crankshaft 156 of an engine 150 is mechanically combined with the power transfer gear 111 which sets a revolving shaft as a driving shaft 112 through planetary gear 120, the motor MG 1, and Motor MG 2 which are mentioned later, and gear association of this power transfer gear 111 is carried out at the differential gear 114. Therefore, finally the power outputted from the power output unit 110 is transmitted to the driving wheel 116,118 on either side. It connects with the control unit 180 electrically, and drive control of a motor MG 1 and the motor MG 2 is carried out by this control unit 180. Although the configuration of a control unit 180 is explained in full detail later, the interior is equipped with Control CPU and accelerator pedal position sensor 164a prepared in the shift position sensor 184 formed in the shift lever 182 or the accelerator pedal 164, brake-

pedal position sensor 165a prepared in the brake pedal 165 are connected. Moreover, the control unit 180 is exchanging various information by EFIECU170 and the communication link which were mentioned above. About control including the exchange of such information, it mentions later.
[0020] As shown in drawing 1 , the power output unit 110 of an example consists of control units 180 which carry out drive control of the motor MG 2 combined with the ring wheel 122 of the motor MG 1 greatly combined with the sun gear 121 of planetary gear 120 and planetary gear 120 with which the planetary carrier 124 was mechanically combined with the crankshaft 156 of an engine 150 and an engine 150, and planetary gear 120, and the motors MG1 and MG2.
[0021] Drawing 2 explains the configuration of planetary gear 120 and motors MG1 and MG2. The sun gear 121 combined with the sun gear shaft 125 in the air with which planetary gear 120 penetrated the shaft center to the crankshaft 156, The ring wheel 122 combined with the crankshaft 156 and the ring wheel shaft 126 of the same axle, Two or more planetary pinion gears 123 which revolve around the sun while it is arranged between a sun gear 121 and a ring wheel 122 and the periphery of a sun gear 121 is rotated, It consists of planetary carriers 124 which are combined with the edge of a crankshaft 156 and support the revolving shaft of each planetary pinion gear 123 to revolve. In these planetary gear 120, the sun gear shaft 125 combined with the sun gear 121, the ring wheel 122, and the planetary carrier 124, respectively, the ring wheel shaft 126, and three shafts of a crankshaft 156 are used as the I/O shaft of power, and if the power outputted and inputted among three shafts to any 2 shafts is determined, the power outputted and inputted by one residual shaft will become settled based on the power outputted and inputted biaxial [which was determined]. In addition, the detail about I/O of the power to three shafts of these planetary gear 120 is mentioned later.
[0022] The power fetch gear 128 for the ejection of power is combined with the ring wheel 122. This power fetch gear 128 is connected to the power transfer gear 111 by the chain belt 129, and transfer of power is made between the power fetch gear 128 and the power transfer gear 111.
[0023] A motor MG 1 is constituted as a synchronous motor generator, and is equipped with Rota 132 which has two or more permanent magnets 135 in a peripheral face, and the stator 133 around which the three phase coil 134 which forms rotating magnetic field was wound. Rota 132 is combined with the sun gear shaft 125 combined with the sun gear 121 of planetary gear 120. A stator 133 carries out the laminating of the sheet metal of a non-oriented magnetic steel sheet, is formed, and is being fixed to the case 119. This motor MG 1 operates as a motor which carries out the rotation drive of Rota 132 by the interaction of the field by the permanent magnet 135, and the field formed with the three phase coil 134, and operates as a generator which makes the both ends of the three phase coil 134 produce electromotive force by the interaction of the field by the permanent magnet 135, and rotation of Rota 132. In addition, the resolver 139 which detects the angle-of-rotation thetas is formed in the sun gear shaft 125.
[0024] A motor MG 2 is constituted as a synchronous motor generator like a motor MG 1, and is equipped with Rota 142 which has two or more permanent magnets 145 in a peripheral face, and the stator 143 around which the three phase coil 144 which forms rotating magnetic field was wound. Rota 142 is combined with the ring wheel shaft 126 combined with the ring wheel 122 of planetary gear 120, and the stator 143 is being fixed to the case 119. The stator 143 of a motor MG 2 also carries out the laminating of the sheet metal of a non-oriented magnetic steel sheet, and is formed. It operates as a motor or a generator like [this motor MG 2] a motor MG 1. In addition, the resolver 149 which detects the angle-of-rotation thetar is formed in the ring wheel shaft 126.
[0025] Next, the control unit 180 which carries out drive control of the motors MG1 and MG2 is explained. As shown in drawing 1 , the control unit 180 consists of dc-batteries 194 which are the control CPU 190 and the rechargeable battery which control the 1st drive circuit 191 which drives a motor MG 1, the 2nd drive circuit 192 which drives a motor MG 2, and both the drive circuit 191,192. Control CPU 190 is one chip microprocessor, and equips the interior with RAM190a for work pieces, ROM190b which memorized the processing program, input/output port (not shown) and EFIECU170, and the serial communication port (not shown) that performs a communication link. In this control CPU 190, angle-of-rotation thetas of the sun gear shaft 125 from a resolver 139, The accelerator pedal position AP from angle-of-rotation thetar of the ring wheel shaft 126 from a resolver 149, and accelerator pedal position sensor 164a (the amount of treading in of an accelerator pedal) The brake-pedal position BP from brake-pedal position sensor 165a (the amount of treading in of a brake pedal), The shift position SP from the shift position sensor 184 The remaining capacity of the current values Iu1 and Iv2 from two current detectors 195,196 prepared in the 1st drive circuit 191, the current values Iu2 and Iv2 from two current detectors 197,198 prepared in the 2nd drive circuit 192, and a dc-battery 194 The remaining capacity BRM from the remaining capacity detector 199 to detect etc. is inputted through input port. In addition, what the remaining capacity detector 199 measures the specific gravity of the electrolytic solution of a dc-battery 194 or the weight of the whole dc-battery 194, and detects remaining capacity, the thing which calculates the current value and time amount of charge and discharge, and detects remaining capacity, the thing which detects remaining capacity by making between the terminals of a dc-battery short-circuit momentarily, and measuring sink internal resistance for a current are known.
[0026] Moreover, from control CPU 190, the control signal SW2 which drives six transistors Tr11 as the control signal SW1 which drives six transistors Tr1 which are the switching elements prepared in the 1st drive circuit 191 thru/or Tr6, and a switching element prepared in the 2nd drive circuit 192 thru/or Tr16 is outputted. Six transistors Tr1 in the 1st drive circuit 191 thru/or Tr6 constitute the transistor inverter, two pieces are arranged at a time in a pair, respectively so that it may become a source and sink side to power-source Rhine L1 and L2 of a pair, and each of the three phase coil (UVW) 34 of a motor MG 1 is connected at the node. Power-source Rhine L1 and L2 controls sequentially the rate of the transistor Tr1 which makes a pair by control CPU 190 since it connects with the plus [of a dc-battery 194], and minus side, respectively thru/or the ON time amount of Tr6 with a control signal SW1, and if the current which flows in each coil of the three phase coil 134 is made into a false sine wave by PWM control, rotating magnetic field will be formed with the three phase coil 134.
[0027] On the other hand, six transistors Tr11 of the 2nd drive circuit 192 thru/or Tr16 also constitute the transistor inverter, is arranged, respectively, and the node of the transistor which makes a pair is connected to each of the three phase coil 144 of a motor MG 2. [as well as the 1st drive circuit 191] Therefore, the transistor Tr11 thru/or the ON time amount of Tr16 which makes a pair by control CPU 190 is sequentially controlled with a control signal SW2, and if the current which flows in each coil 144 is made into a false sine wave by PWM control, rotating magnetic field will be formed with the three phase coil 144.
[0028] Actuation of the power output unit 110 of the example which explained the configuration above is explained. The principle of operation of the power output unit 110 of an example, especially the principle of torque conversion are as follows. When operating an engine 150 on the operation point P1 of an engine speed Ne and Torque Te and operating the ring wheel shaft 126 on the operation point P2 of an engine speed Nr which is different although it is the same energy as the energy Pe outputted

from this engine 150, and Torque Tr, the case where carry out torque conversion and the power outputted from an engine 150 is made to act on the ring wheel shaft 126 is considered. The engine 150 at this time, the rotational frequency of the ring wheel shaft 126, and the relation of torque are shown in drawing 4 .
[0029] According to the place which device study teaches, the relation between the rotational frequency in three shafts (the sun gear shaft 125, the ring wheel shaft 126, and planetary carrier 124 (crankshaft 156)) of planetary gear 120 or torque can be expressed as drawing called the collinear Fig. illustrated to drawing 5 and drawing 6 , and can be solved geometrically. In addition, the rotational frequency of three shafts and the relation of torque to planetary gear 120 are also analyzable in formula by calculating the energy of each shaft etc., even if it does not use an above-mentioned collinear Fig. By this example, since explanation is easy, it explains using a collinear Fig.
[0030] The axis of ordinate in drawing 5 is a rotational frequency shaft of three shafts, and an axis of abscissa expresses the ratio of the location of the axis of coordinates of three shafts. That is, when the axes of coordinates S and R of the sun gear shaft 125 and the ring wheel shaft 126 are taken to both ends, the axis of coordinates C of the planetary carrier 124 is defined as a shaft which divides Shaft S and Shaft R interiorly to 1:rho. rho is the ratio of the number of teeth of a sun gear 121 to the number of teeth of a ring wheel 122 here, and it is expressed with a degree type (1).
[0031]
[Equation 1]

$$\rho = \frac{\text{サンギヤの歯数}}{\text{リングギヤの歯数}} \quad \cdots\cdots(1)$$

[0032] The engine 150 is operated at the rotational frequency Ne, since the case where the ring wheel shaft 126 is operated at the rotational frequency Nr is considered, the rotational frequency Ne of an engine 150 can be now plotted on the axis of coordinates C of the planetary carrier 124 with which the crankshaft 156 of an engine 150 is combined, and a rotational frequency Nr can be plotted on the axis of coordinates R of the ring wheel shaft 126. If the straight line which passes along both this point is drawn, it can ask for the rotational frequency Ns of the sun gear shaft 125 as a rotational frequency expressed on the intersection of this straight line and axis of coordinates S. Hereafter, this straight line is called a collinear of operation. In addition, it can ask for a rotational frequency Ns by the proportion equation (degree type (2)) using a rotational frequency Ne and a rotational frequency Nr. Thus, in planetary gear 120, if it opts for any two rotations among a sun gear 121, a ring wheel 122, and the planetary carrier 124, it will opt for one residual rotation based on two rotations for which it opted.
[0033]
[Equation 2]

$$Ns = Nr - (Nr - Ne)\frac{1+\rho}{\rho} \quad \cdots\cdots(2)$$

[0034] Next, the torque Te of an engine 150 is made to act on the drawn collinear of operation upwards from drawing Nakashita by making the axis of coordinates C of the planetary carrier 124 into line of action. Since a collinear of operation can be dealt with as the rigid body at the time of making the force as a vector act to torque at this time, the torque Te made to act on an axis of coordinates C is separable into the torque Tes on an axis of coordinates S, and the torque Ter on an axis of coordinates R with the technique of separation of the force to two parallel different line of action. The magnitude of Torque Tes and Ter is expressed by a degree type (3) and (4) at this time.
[0035]
[Equation 3]

$$Tes = Te \times \frac{\rho}{1+\rho} \quad \cdots\cdots(3)$$

$$Ter = Te \times \frac{1}{1+\rho} \quad \cdots\cdots(4)$$

[0036] What is necessary is just to take balance of the force of a collinear of operation, in order for the collinear of operation to be stable in this condition. That is, magnitude is the same as Torque Tes, the torque Tm1 with the opposite sense is made to act, magnitude is the same to resultant force with torque and Torque Ter with the opposite sense on an axis of coordinates R in the same magnitude as the torque Tr outputted to the ring wheel shaft 126, and the sense makes the opposite torque Tm2 act on an axis of coordinates S. This torque Tm1 can act by the motor MG 1, and torque Tm2 can be made to act by the motor MG 2. Since torque is made to act on a rotational direction and the rotational reverse sense by the motor MG 1 at this time, a motor MG 1 will operate as a generator and revives electrical energy Pm1 expressed with the product of torque Tm1 and a rotational frequency Ns from the sun gear shaft 125. By the motor MG 2, since the direction of torque is the same as the direction of rotational, a motor MG 2 operates as a motor and is outputted to the ring wheel shaft 126 by making into power electrical energy Pm2 expressed by the product of torque Tm2 and a rotational frequency Nr.
[0037] Here, if electrical energy Pm1 and electrical energy Pm2 are made equal, all the power consumed by the motor MG 2 can be revived by the motor MG 1, and it can be provided. What is necessary is for that just to make equal the thing which outputs all the inputted energy then the energy Pe outputted from an engine 150 since it is good, and energy Pr outputted to the ring wheel shaft 126. That is, the energy Pe expressed with the product of Torque Te and a rotational frequency Ne and energy Pr expressed with the product of Torque Tr and a rotational frequency Nr are made equal. If it compares with drawing 4 , torque conversion will be carried out and the power expressed with the torque Te outputted from the engine 150 currently operated on the operation point P1 and a rotational frequency Ne will be outputted to the ring wheel shaft 126 as power expressed with the same energy at Torque Tr and a rotational frequency Nr. As mentioned above, the power outputted to the ring wheel shaft 126 is transmitted to a driving shaft 112 by the power fetch gear 128 and the power transfer gear 111, and is transmitted to a driving wheel 116,118 through a differential gear 114. Therefore, since linear relation is materialized for the power outputted to the ring wheel shaft 126, and the power transmitted to a driving wheel 116,118, the power transmitted to a driving wheel 116,118 is controllable by controlling the power outputted to the ring wheel shaft 126.
[0038] Although the engine speed Ns of the sun gear shaft 125 is forward in the collinear Fig. shown in drawing 5 , as shown in the collinear Fig. shown in drawing 6 , it may become negative at the engine speed Ne of an engine 150, and the engine speed Nr of the ring wheel shaft 126. At this time, by the motor MG 1, since the direction of rotational and the direction where torque acts

become the same, a motor MG 1 operates as a motor and consumes electrical energy Pm1 expressed by the product of torque Tm1 and a rotational frequency Ns. On the other hand, by the motor MG 2, since the direction of rotational and the direction where torque acts become reverse, a motor MG 2 will operate as a generator and will revive electrical energy Pm2 expressed by the product of torque Tm2 and a rotational frequency Nr from the ring wheel shaft 126. In this case, if electrical energy Pm1 consumed by the motor MG 1 and electrical energy Pm2 revived by the motor MG 2 are made equal, electrical energy Pm1 consumed by the motor MG 1 can be exactly provided by the motor MG 2.

[0039] As mentioned above, although the fundamental torque conversion in the power output unit 110 of an example was explained The power outputted from an engine 150 besides the actuation which the power output unit 110 of an example carries out torque conversion of all the power outputted from such an engine 150, and is outputted to the ring wheel shaft 126 (product of Torque Te and a rotational frequency Ne), By adjusting electrical energy Pm1 revived or consumed by the motor MG 1, and electrical energy Pm2 consumed or revived by the motor MG 2 It can consider as the actuation which finds out excessive electrical energy and discharges a dc-battery 194, or can also consider as various actuation, such as actuation with which the electrical energy running short is compensated with the power stored in the dc-battery 194.

[0040] In addition, the above principle of operation explained the conversion efficiency of the power by planetary gear 120, a motor MG 1, a motor MG 2 and a transistor Tr1, or Tr16 as a value 1 (100%). Since it is less than one value in fact, it is necessary to make energy Pr which makes a bigger value a little than the energy Pr which outputs the energy Pe outputted from an engine 150 to the ring wheel shaft 126, or is conversely outputted to the ring wheel shaft 126 into a value [a little] smaller than the energy Pe outputted from an engine 150. For example, what is necessary is just to consider as the value computed by multiplying by the inverse number of conversion efficiency by the energy Pr outputted to the ring wheel shaft 126 in the energy Pe outputted from an engine 150. Moreover, what is necessary is to consider as the value computed from what multiplied the power revived by the motor MG 1 in the condition of the collinear Fig. of drawing 5 in the torque Tm2 of a motor MG 2 by the effectiveness of both motors, and just to compute the power consumed by the motor MG 1 in the condition of the collinear Fig. of drawing 6 from what was broken by effectiveness of both motors. In addition, although energy is lost as heat by machine friction etc. in planetary gear 120, there are very few the amounts of loss, if it sees from the amount of whole, and the effectiveness of the synchronous motor used for motors MG1 and MG2 is very close to a value 1. Moreover, very small things, such as GTO, are known also for a transistor Tr1 thru/or the on resistance of Tr16. Therefore, since it becomes a thing near a value 1, and the following explanation is also easy for explanation, the conversion efficiency of power is dealt with as a value 1 (100%), unless it shows clearly.

[0041] Next, the actual condition of the torque control in the power output unit 110 of such an example is explained based on the torque control routine illustrated to drawing 7 . This routine is repeatedly performed for every (every [for example,] 4msec) predetermined time, after setting directions of initiation of operation of an operator, for example, an ignition switch, to ON. If this routine is performed, the control CPU 190 of a control unit 180 will first perform processing which reads the rotational frequency Ns of the sun gear shaft 125, and the rotational frequency Nr of the ring wheel shaft 126 (step S100). It can ask for the engine speed Ns of the sun gear shaft 125 from angle-of-rotation thetas of the sun gear shaft 125 detected by the resolver 139, and can ask for the engine speed Nr of the ring wheel shaft 126 from angle-of-rotation thetar detected by the resolver 149.

[0042] Then, processing which inputs the accelerator pedal position AP detected by accelerator pedal position sensor 164a is performed (step S102). Since an accelerator pedal 164 is broken in when it senses that an operator's output torque is insufficient, the accelerator pedal position AP corresponds to the output torque (namely, torque which should be outputted to a driving wheel 116,118) which the operator wants. If the accelerator pedal position AP is read, processing which derives torque command value Tr* which is the desired value of the torque which should be outputted to the ring wheel shaft 126 based on the read accelerator pedal position AP and the rotational frequency Nr of the ring wheel shaft 126 will be performed (step S104). The torque which should be outputted to the ring wheel shaft 126 is derived without the ability being able to draw the torque which should be outputted to a driving wheel 116,118 here because the ring wheel shaft 126 will result in deriving the torque which should be outputted to a driving wheel 116,118, if the torque which should be outputted to the ring wheel shaft 126 is derived, since it is mechanically combined with the driving wheel 116,118 through the power fetch gear 128, the power transfer gear 111, and the differential gear 114. In addition, in the example, the value of torque command value Tr* shall be derived based on the map which memorized beforehand the map in which the relation between the engine speed Nr of the ring wheel shaft 126, and the accelerator pedal position AP and torque command value Tr* is shown to ROM190b, and was memorized to the read accelerator pedal position AP, the engine speed Nr of the ring wheel shaft 126, and ROM190b when the accelerator pedal position AP was read. An example of this map is shown in drawing 8 .

[0043] Next, the energy Pr which should be outputted to the ring wheel shaft 126 is searched for by count (Pr=Tr*xNr) from drawn torque command value Tr* and the rotational frequency Nr of the ring wheel shaft 126 (step S106), and processing which sets up target torque Te* of an engine 150 and target rotational frequency Ne* based on the energy Pr searched for is performed (step S108). Here, since the energy Pe outputted from an engine 150 is equal to the product of the Torque Te and engine speed Ne, the relation with target torque Te* of Energy Pr and an engine 150 and target engine-speed Ne* which should be outputted to the ring wheel shaft 126 becomes Pr=Pe=Te*xNe*. The combination of target torque Te* of an engine 150 and target rotational frequency Ne* which satisfy this relation exists innumerably. So, in an example, an engine 150 is operated by experiment etc. in the condition that effectiveness is high as much as possible, to each energy Pr. And it asks for the operation point from which the operational status of an engine 150 changes smoothly to change of Energy Pr as a combination of target torque Te* and target rotational frequency Ne*. This shall be beforehand memorized as a map to ROM190b, and the combination of target torque Te* and target rotational frequency Ne* corresponding to Energy Pr shall be derived from this map. This map is explained further.

[0044] Drawing 9 is a graph which shows the relation between the operation point of an engine 150, and the effectiveness of an engine 150. The curve B in drawing shows the boundary of the field which can operate an engine 150. it is like [the field which can operate an engine 150] the curve alpha 1 which shows the operation point with the same effectiveness according to the property thru/or alpha 6 -- etc. -- an effectiveness line can be drawn. Moreover, the curve 1 with the fixed energy expressed with the product of Torque Te and a rotational frequency Ne, for example, curvilinear C1-C, and C3-C3 can be drawn on the field which can operate an engine 150. In this way, if the rotational frequency Ne of an engine 150 is expressed for the effectiveness of each operation point as an axis of abscissa along with drawn curvilinear C1-C1 of energy regularity thru/or C3-C3, it will become like the graph of drawing 10 .

[0045] But the effectiveness of an engine 150 differs greatly by on which operation point it operates with the same energy to output so that it may illustrate. For example, on the fixed curvilinear C1-energy C 1, the effectiveness can be made the highest

by operating an engine 150 on the operation point A1 (torque Te 1, rotational frequency Ne1). In curvilinear C2-C2 of output energy regularity, and C3-C3, the operation point with such highest effectiveness exists on the curve of each energy regularity so that the operation point A2 and A3 may correspond, respectively. The curve A in drawing 9 is connected with the line which continues the operation point with which the effectiveness of an engine 150 becomes as high as possible to each energy Pr based on these things. In the example, target torque Te* of an engine 150 and target engine-speed Ne* were set up using what used each operation point on this curve A (Torque Te, engine speed Ne), and relation with Energy Pr as the map.
[0046] Here, Curve A is connected with a continuous curve because the operational status of an engine 150 will change suddenly and it cannot shift to target operational status smoothly depending on extent of the change, but knocking may be produced or it may stop, when Energy Pr changes ranging over the discontinuous operation point if the operation point of an engine 150 is defined with a discontinuous curve to change of Energy Pr. Therefore, if Curve A is connected with a continuous curve in this way, each operation point on Curve A may not turn into the operation point with the highest effectiveness on the curve of energy regularity. In addition, the operation point Amin with which it is expressed at Torque Temin and an engine speed Nemin is the operation point of the threshold energy in which an engine 150 to an output is possible among drawing 9 .
[0047] If target torque Te* of an engine 150 and target engine-speed Ne* are set up, control CPU 190 will calculate target engine-speed Ns* of the sun gear shaft 125 by replacing with the engine speed Ne of an engine 150, and substituting target engine-speed Ne* of an engine 150 for the formula (2) mentioned above (step S110). And using target rotational frequency Ns* of the calculated sun gear shaft 125, and drawn torque command value Tr*, torque command value Tm1* of a motor MG 1 is calculated by the degree type (5), and it sets up (step S112). The 1st term of the right-hand side in a formula (5) is searched for here from balance of drawing 5 and the collinear of operation in the collinear Fig. of drawing 6 , the 2nd term of the right-hand side is a proportional which negates the deflection from target rotational frequency Ns* of a rotational frequency Ns, and the 3rd term of the right-hand side is an integral term which abolishes steady-state deviation. Therefore, torque command value Tm1* of a motor MG 1 will be set up by the steady state equally to Tr*xrho of the 1st term of the right-hand side searched for from balance of a collinear of operation (when the deflection from target rotational frequency Ns* of a rotational frequency Ns is a value 0). In addition, K1 and K2 in a formula (5) are a proportionality constant.
[0048]
[Equation 4]

$$Tm1^* \leftarrow Tr^* \times \rho + K1(Ns^* - Ns) + K2\int (Ns^* - Ns)dt \quad \cdots\cdots(5)$$

[0049] Then, based on the rotational frequency Ns of the sun gear shaft 125, the angular acceleration domegas which is the rate of change of the rotational speed of the sun gear shaft 125 is calculated by the degree type (6) (step S114). Here, "last Ns" is the engine speed Ns of the sun gear shaft 125 inputted at step S100 when this routine was started last time, and **t is starting spacing time amount **t of this routine. "2pi" of the molecule of the right-hand side of a formula (6) is based on angular-velocity omegas of the sun gear shaft 125 and a rotational frequency Ns having the relation of omegas=2 pixNs [rad/sec]. In addition, since a value 0 is inputted last time into Ns by the initialization routine which is performed before this routine is performed and which is not illustrated when it begins after the ignition switch was set to ON, and this routine is started, this value 0 is used.
[0050]
[Equation 5]

$$d\omega s \leftarrow \frac{\frac{2\pi}{60}(Ns - \text{前回}Ns)}{\Delta t} \quad \cdots\cdots(6)$$

[0051] In this way, if it asks for the angular acceleration domegas of the sun gear shaft 125, the torque Ter outputted to the ring wheel shaft 126 by the degree type (7) through planetary gear 120 using this angular acceleration domegas will be calculated (step S116). Here, "Ime" of the 2nd term of a right-hand-side molecule in a formula (7) is the moment of inertia of the motor MG 1 seen from the motor MG 1 of the system of inertia which consists of a motor MG 1 mechanically combined through planetary gear 120, and an engine 150, and an engine 150. Therefore, what multiplied the moment of inertia Ime seen from this motor MG 1 by the angular acceleration domegas of Rota 132 of a motor MG 1 serves as torque (henceforth inertia torque) which acts on the sun gear shaft 125, and the right-hand-side molecule of a formula (7) serves as resultant force of the torque which acts on the sun gear shaft 125. In addition, since inertia torque acts on the reverse sense to the direction of change of movement by law of inertia, when it considers the time of changing the operation point of an engine 150 into the operation point with a big rotational frequency Ne, inertia torque will have a negative sign in the formula of Torque Ter which will act in the direction which controls the rise of a rotational frequency Ne, and acts on the ring wheel shaft 126. From the first, when changing the operation point of an engine 150 into the operation point with a small rotational frequency Ne, inertia torque acts in the direction which controls reduction of a rotational frequency Ne. Moreover, when an engine 150 is in a steady operation condition, since the angular acceleration domegas of the sun gear shaft 125 serves as a value 0, inertia torque also serves as a value 0.
[0052]
[Equation 6]

$$Ter = \frac{Tm1^* - \mathrm{Im}e \times d\omega s}{\rho} \quad \cdots\cdots(7)$$

[0053] Thus, if the torque Ter outputted to the ring wheel shaft 126 through planetary gear 120 is calculated, from torque command value Tr*, torque command value Tm2* of a motor MG 2 will be computed by reducing this torque Ter, and will be set up (step S118). And each control of a motor MG 1, a motor MG 2, and an engine 150 is performed using each set-up set point (step S120 thru/or S124). In the example, on account of illustration, although each control of a motor MG 1, a motor MG 2, and an engine 150 was indicated as a separate step, these control is performed to coincidence in parallel and synthetically in fact. For example, while control CPU 190 performs control of a motor MG 1 and a motor MG 2 in parallel with coincidence using interruption processing, EFIECU170 which received directions by communication link is made to also perform control of an engine 150 to coincidence.
[0054] Control (step S120 of drawing 7) of a motor MG 1 is made by the control routine of the motor MG 1 illustrated to drawing 11 . If this routine is performed, the control CPU 190 of a control unit 180 will perform first processing which inputs angle-of-rotation thetas of the sun gear shaft 125 from a resolver 139 (step S180). Then, processing which detects the currents Iu1 and

Iv1 which are flowing to U phase and V phase of the three phase coil 134 of a motor MG 1 with the current detector 195,196 is performed (step S182). Although the current is flowing to the three phase of U, V, and W, since the total is zero, it is sufficient if the current which flows to two phases is measured. In this way, coordinate transformation (three phase -2 phase-number conversion) is performed using the current of the obtained three phase (step S184). Coordinate transformation is changing into the current value of d shaft of the synchronous motor of a permanent-magnet type, and q shaft, and is performed by calculating a degree type (8). Coordinate transformation is performed in the synchronous motor of a permanent-magnet type here because it is an amount with the current of d shaft and q shaft essential when controlling torque. It is also possible to control from the first with a three phase.
[0055]
[Equation 7]

$$\begin{bmatrix} Id1 \\ Iq1 \end{bmatrix} = \sqrt{2} \begin{bmatrix} -\sin(\theta s-120) & \sin\theta s \\ -\cos(\theta s-120) & \cos\theta s \end{bmatrix} \begin{bmatrix} Iu1 \\ Iv1 \end{bmatrix} \quad \cdots\cdots(8)$$

[0056] Next, after changing into a biaxial current value, processing which asks for current command value Id1* of each shaft searched for from torque command value Tm1* in a motor MG 1, Iq1*, the currents Id1 and Iq1 that actually flowed on each shaft, and deflection, and calculates the electrical-potential-difference command values Vd1 and Vq1 of each shaft is performed (step S186). That is, the following formulas (9) are calculated first and then a degree type (10) is calculated. Here, Kp1, Kp2, Ki1, and Ki2 are multipliers respectively. These multipliers are adjusted so that the property of the motor to apply may be suited. In addition, the electrical-potential-difference command values Vd1 and Vq1 are calculated from the part (the 1st term of the formula (10) right-hand side) proportional to deflection **I with current command value I*, and an accumulated part (the 2nd term of the right-hand side) of the past of i batch of deflection **I.
[0057]
[Equation 8]

$$\Delta Id1 = Id1^* - Id1$$
$$\Delta Iq1 = Iq1^* - Iq1 \quad \cdots\cdots(9)$$
$$Vd1 = Kp1 \cdot \Delta Id1 + \sum Ki1 \cdot \Delta Id1$$
$$Vq1 = Kp2 \cdot \Delta Iq1 + \sum Ki2 \cdot \Delta Iq1 \quad \cdots\cdots(10)$$

[0058] Then, coordinate transformation (two phase -3 phase-number conversion) equivalent to the inverse transformation of the conversion which performed the electrical-potential-difference command value calculated in this way at step S184 is performed (step S188), and processing which asks for the electrical potential differences Vu1, Vv1, and Vw1 actually impressed to the three phase coil 134 is performed. It asks for each electrical potential difference by the degree type (11).
[0059]
[Equation 9]

$$\begin{bmatrix} Vu1 \\ Vv1 \end{bmatrix} = \sqrt{\frac{2}{3}} \begin{bmatrix} \cos\theta s & -\sin\theta s \\ \cos(\theta s-120) & -\sin(\theta s-120) \end{bmatrix} \begin{bmatrix} Vd1 \\ Vq1 \end{bmatrix}$$
$$Vw1 = -Vu1 - Vv1 \quad \cdots\cdots(11)$$

[0060] Since actual armature-voltage control is made by the transistor Tr1 of the 1st drive circuit 191 thru/or the on-off time amount of Tr6, it carries out PWM control of each transistor Tr1 thru/or the ON time amount of Tr6 so that it may become each electrical-potential-difference command value calculated by the formula (11) (step S199).
[0061] If the sense of the torque [in / for the sign of torque command value Tm1* of a motor MG 1 / the collinear Fig. of drawing 5 or drawing 6] Tm1 is made forward here Even if torque command value Tm1* of the same forward value is set up, when the sense on which torque command value Tm1* acts like the condition of the collinear Fig. of drawing 5 differs from the sense of rotation of the sun gear shaft 125, regenerative control is made, and power running control is made like the condition of the collinear Fig. of drawing 6 at the time of the same direction. However, since power running control of a motor MG 1 and regenerative control control the transistor Tr1 of the 1st drive circuit 191 thru/or Tr6 so that forward torque acts on the sun gear shaft 125 by the permanent magnet 135 attached in the peripheral face of Rota 132, and the rotating magnetic field produced according to the current which flows in the three phase coil 134 if torque command value Tm1* is forward, they turn into the same switching control. That is, if the sign of torque command value Tm1* is the same, even if control of a motor MG 1 is regenerative control and it is power running control, it will become the same switching control. Therefore, all of the regenerative control and power running control by the control routine of the motor MG 1 of drawing 11 can be performed. Moreover, since the direction of change of angle-of-rotation thetas of the sun gear shaft 125 read at step S180 only becomes reverse when torque command value Tm1* is negative, the control routine of the motor MG 1 of drawing 11 can also perform control at this time.
[0062] In addition, although it is possible to control a motor MG 1 by the control routine of the motor MG 1 of drawing 11 even when a value 0 is set as torque command value Tm1* of a motor MG 1, at this time, it is good also as control which makes off all the transistors Tr1 thru/or Tr(s)6.
[0063] Next, control processing (step S122 of drawing 7) of a motor MG 2 is explained based on the control routine of the motor MG 2 illustrated to drawing 12 . control processing of a motor MG 2 -- control processing of a motor MG 1 -- it replaces with torque command value Tm1* and angle-of-rotation thetas of the sun gear shaft 125 inside, and is completely the same as that of control processing of a motor MG 1 except for the point using torque command value Tm2* and angle-of-rotation thetar of the ring wheel shaft 126. Namely, angle-of-rotation thetar of the ring wheel shaft 126 is detected using a resolver 149 (step S190). Then, each phase current of a motor MG 2 is detected using the current detector 197,198 (step S192). Then, the operation of coordinate transformation (step S194) and the electrical-potential-difference command values Vd2 and Vq2 is performed (step S196). Furthermore, backseat label conversion (step S198) of an electrical-potential-difference command value is performed, the transistor Tr11 of the 2nd drive circuit 192 of a motor MG 2 thru/or the on-off control time amount of Tr16 are found, and PWM control is performed (step S199).
[0064] Although power running control of the motor MG 2 is carried out by the sense of torque command value Tm2*, and the sense of rotation of the ring wheel shaft 126 here or regenerative control is carried out, both power running control and

regenerative control can be performed by control processing of the motor MG 2 of drawing 12 like a motor MG 1. In addition, in the example, the sign of torque command value Tm2* of a motor MG 2 made forward the sense of the torque Tm2 at the time of the condition of the collinear Fig. of drawing 5 .
[0065] Next, control (step S124 of drawing 7) of an engine 150 is explained. Torque Te and the rotational frequency Ne of an engine 150 are controlled so that an engine 150 will be in a steady operation condition on the set-up operation point, if the operation point made into the target is set up by target torque Te* and target rotational frequency Ne*. Directions are transmitted to EFIECU170 by communication link from control CPU 190, and the opening of the fuel oil consumption from a fuel injection valve 151 or a throttle valve 166 is specifically fluctuated, and it adjusts gradually so that the output torque of an engine 150 may become target torque Te* and a rotational frequency may become target rotational frequency Ne*. In addition, by control of an engine 150, as shown in the formula (5) mentioned above, since the rotational frequency Ne of an engine 150 is performed by control of the rotational frequency Ns of the sun gear shaft 125 by the motor MG 1, target torque Te* serves as control of a throttle valve 166, and Air Fuel Ratio Control to an inhalation air content so that may be outputted from an engine 150. In addition, when the halt command of operation of an engine 150 is outputted from control CPU 190, while carrying out the close by-pass bulb completely of the throttle valve 166, it becomes processing of a halt of fuel injection, and a halt of ignition.
[0066] Inertia torque required to change the operation point according to the power output unit 110 of an example explained above, when the operation point of an engine 150 is changed is computed. Also in the transient which changes the operation point of an engine 150 since torque command value Tm2* of a motor MG 2 is computed in consideration of this inertia torque and a motor MG 2 is driven The torque which an operator wants can be outputted to the ring wheel shaft 126, as a result a driving wheel 116,118. Moreover, when an engine 150 is in a steady operation condition, since the torque Ter outputted to the ring wheel shaft 126 through planetary gear 120 since the angular acceleration domegas of the sun gear shaft 125 serves as a value 0 will be searched for by balance of drawing 5 and the collinear of operation in the collinear Fig. of drawing 6 , it can output the torque which an operator wants to the ring wheel shaft 126. Therefore, the smooth transient characteristic which does not have a torque shock in the ring wheel shaft 126 can be acquired.
[0067] From the first, according to the power output unit 110 of an example, torque conversion can be carried out and it can output to the power which consists of the torque and the rotational frequency of a request of the energy Pe outputted from an engine 150 at the ring wheel shaft 126.
[0068] It asks for the angular acceleration domegas of the sun gear shaft 125 in the power output unit 110 of an example. Although the torque Ter which computes the inertia torque which takes advantaging of the moment of inertia of the system of inertia which consists of a motor MG 1 which saw this from the motor MG 1, and an engine 150, and acts on the sun gear shaft 125, and is outputted to the ring wheel shaft 126 through planetary gear 120 was searched for Ask for the angular acceleration domegae of a crankshaft 156, and the inertia torque which takes advantaging of the moment of inertia of the system of inertia which consists of an engine 150 which saw this from the engine 150, and a motor MG 1, and acts on a crankshaft 156 is searched for. It is good also as what computes Torque Ter based on this. What is necessary is to replace with processing of steps S114 and S116 of the torque control routine illustrated to drawing 7 in this case, and just to perform step S214 of a torque control routine thru/or the processing of S216 illustrated to drawing 13 . In this processing, the rotational frequency Ne of an engine 150 is inputted (step S214), based on the inputted rotational frequency Ne, the angular acceleration domegae of a crankshaft 156 is calculated by the formula (6) and the same formula (step S215), and Torque Ter is computed by the degree type (12) using this angular acceleration domegae (step S216). "Iem" of the 2nd term of the right-hand side in a formula (12) is the moment of inertia of the engine 150 seen from the engine 150 of the system of inertia which consists of an engine 150 mechanically combined through planetary gear 120, and a motor MG 1, and a motor MG 1. In addition, the rotational frequency Ne of an engine 150 is good also as what transforms and asks for a formula (2) from the rotational frequency Ns of the sun gear shaft 125, and the rotational frequency Nr of the ring wheel shaft 126, and you may ask for it from angle of rotation of the crankshaft 156 which installs a resolver in a crankshaft 156 and is detected from this resolver. Moreover, it is good also as what inputs the signal detected by the rotational frequency sensor 176 attached in the distributor 160 by the communication link from EFIECU170.
[0069]
[Equation 10]

$$Ter \leftarrow \frac{Tm1^*}{\rho} - \frac{Iem \times d\omega e}{1+\rho} \quad \cdots\cdots(12)$$

[0070] Although the power output unit 110 of an example shall be provided by the energy Pe which sets up target torque Te* of an engine 150, and target engine-speed Ne* based on the energy Pr which should be outputted to the ring wheel shaft 126, and is outputted from an engine 150 Shall provide a part of energy Pr which should be outputted to the ring wheel shaft 126 with the electrical energy which discharges from a dc-battery 194, or It is good also as what operates an engine 150 so that the energy Pe more superfluous than Energy Pr may be outputted, and charges a dc-battery 194 by residual energy. In this case, what is necessary is just to let the formula of step S108 of the torque control routine of drawing 7 be a degree type (13). In addition, Pb in this formula (13) is electrical energy by which charge and discharge are carried out from a dc-battery 194, and when charging a dc-battery 194 and discharging from a dc-battery 194 with a forward value, it serves as a negative value. if it carries out like this, while performing the charge and discharge of a dc-battery 194 -- **** -- it can be stabilized and the torque which an operator wants can be outputted to the ring wheel shaft 126.
[0071]
Pr+Pb=Te*xNe* -- (13)
[0072] Although the power output unit 110 of an example explained the time of an engine 150 continuing, and being operated and the operation point being changed, the torque control routine of drawing 7 is applicable also to the transient at the time of suspending operation of an engine 150. In this case, what is necessary is just to set a value 0 as target torque Te* and target rotational frequency Ne*. In addition, when operation of an engine 150 was suspended, the operator may have given the directions which suspend an engine 150 the time when the energy Pr which should be outputted to the ring wheel shaft 126 is smaller than the minimum energy Pe (energy Pe in the operation point Amin with which it is expressed at Torque Temin and a rotational frequency Nemin among drawing 9) in which an engine 150 to an output is possible, and for the purposes, such as environmental preservation.
[0073] Although target torque Te* and target rotational frequency Ne* were set up in the power output unit 110 of an example so that the effectiveness of an engine 150 might become high, it is good also as what sets up target torque Te* and target

rotational frequency Ne* so that emission may become good, and a thing which sets up target torque Te* and target rotational frequency Ne* so that the sound of an engine 150 may become small.
[0074] Although the power outputted to the ring wheel shaft 126 was taken out from between a motor MG 1 and motors MG 2 through the power fetch gear 128 combined with the ring wheel 122 in the power output unit 110 of an example, as shown in power output unit 110A of the modification of drawing 14 , it is good also as what extends and picks out the ring wheel shaft 126 from a case 119. Moreover, as shown in power output unit 110B of the modification of drawing 15 , you may arrange so that it may become the order of planetary gear 120, a motor MG 2, and a motor MG 1 from an engine 150 side. In this case, sun gear shaft 125B may not be hollow, and ring wheel shaft 126B needs to be taken as a hollow shaft. If it carries out like this, the power outputted to ring wheel shaft 126B can be taken out from between an engine 150 and motors MG 2.
[0075] Although it shall apply to the car of a two-flower drive of FR mold or FF mold in the power output unit 110 of an example, and its modification, as shown in power output unit 110C of the modification of drawing 16 , it is good also as what is applied to the car of a four-flower drive. With this configuration, the motor MG 2 combined with the ring wheel shaft 126 is separated from the ring wheel shaft 126, it arranges independently in the rear wheel section of a car, and the driving wheel 117,119 of the rear wheel section is driven by this motor MG 2. On the other hand, it is combined with a differential gear 114 through the power fetch gear 128 and the power transfer gear 111, and the ring wheel shaft 126 drives the driving wheel 116,118 of the front-wheel section. It is possible to perform the torque control routine of drawing 7 mentioned above under such a configuration.
[0076] As mentioned above, although the gestalt of operation of this invention was explained, as for this invention, it is needless to say that it can carry out with the gestalt which becomes various within limits which are not limited to the gestalt of such operation at all, and do not deviate from the summary of this invention.
[0077] For example, in the power output unit 110 of the example mentioned above, although the gasoline engine was used as an engine 150, various kinds of internal combustion, such as a diesel power plant, a turbine engine, and a jet engine, or an external combustion engine can also be used.
[0078] Moreover, although planetary gear 120 were used as a 3 shaft type power I/O means in the power output unit 110 of an example, a sun gear and another side of one side are good also as a thing using double pinion planetary gear equipped with two or more set Mino planetary 2 1 set of pinion gears which revolve around the sun while carrying out gear association with a ring wheel, carrying out gear association mutually and rotating the periphery of a sun gear. In addition, if the power which will be outputted and inputted by one residual shaft based on this determined power if the power outputted and inputted by any 2 shafts among three shafts as a 3 shaft type power I/O means is determined is determined, what kind of equipment, gear unit, etc. can also use a differential gear etc.
[0079] Furthermore, in the power output unit 110 of an example, although PM form (permanent magnet form-ermanent Magnet type) synchronous motor was used for the motor MG 1 and the motor MG 2, if the both sides of regeneration actuation and a powering movement are possible, VR form (adjustable reluctance form; Variable Reluctance type) synchronous motor, a vernier motor, a direct current motor, an induction motor, a superconducting motor, a step motor, etc. can also be used.
[0080] Or in the power output unit 110 of an example, although the transistor inverter was used as 1st and 2nd drive circuits 191,192, an IGBT (insulated-gate bipolar mode transistor; Insulated Gate Bipolar mode Transistor) inverter, a thyristor inverter, an electrical-potential-difference PWM (pulse-width-modulation-ulse Width Modulation) inverter, a square wave inverter (an electrical-potential-difference form inverter, current form inverter), a resonance inverter, etc. can also be used.
[0081] Moreover, as a dc-battery 194, although Pb dc-battery, a NiMH dc-battery, Li dc-battery, etc. can be used, it can replace with a dc-battery 194 and a capacitor can also be used.
[0082] Although the above example explained the case where a power output unit was carried in a car, this invention is not limited to this and, in addition to this, can also be carried [means of transportation, such as a vessel and an aircraft, and] in various industrial machines etc.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the outline configuration of the power output unit 110 as one example of this invention.
[Drawing 2] It is the partial enlarged drawing of the power output unit 110 of an example.
[Drawing 3] It is the block diagram which illustrates the configuration of the outline of the car incorporating the power output unit 110 of an example.
[Drawing 4] It is a graph for explaining the principle of operation of the power output unit 110 of an example.
[Drawing 5] It is the collinear Fig. showing the rotational frequency of three shafts and the relation of torque which were combined with the planetary gear 120 in an example.
[Drawing 6] It is the collinear Fig. showing the rotational frequency of three shafts and the relation of torque which were combined with the planetary gear 120 in an example.
[Drawing 7] It is the flow chart which illustrates the torque control routine performed by the control device 180 of an example.
[Drawing 8] It is the explanatory view which illustrates the relation between the engine speed Nr of the ring wheel shaft 126, and the accelerator pedal position AP and torque command value Tr*.
[Drawing 9] It is the graph which illustrates the operation point of an engine 150, and the relation of effectiveness.
[Drawing 10] It is the graph which illustrates the relation between the effectiveness of the operation point of the engine 150 in alignment with the curve of energy regularity, and the rotational frequency Ne of an engine 150.
[Drawing 11] It is the flow chart which illustrates fundamental processing of control of the motor MG 1 performed by the control CPU 190 of a control unit 180.
[Drawing 12] It is the flow chart which illustrates fundamental processing of control of the motor MG 2 performed by the control CPU 190 of a control unit 180.
[Drawing 13] It is the flow chart which illustrates a part of torque control routine of a modification.
[Drawing 14] It is the block diagram showing the outline configuration of power output unit 110A of a modification.
[Drawing 15] It is the block diagram showing the outline configuration of power output unit 110B of a modification.
[Drawing 16] It is the block diagram showing the outline configuration of the car incorporating power output unit 110C which is an example when applying the power output unit 110 of an example to a four-wheel drive car.
[Description of Notations]
110 — Power output unit
110A-110C — Power output unit
111 — Power transfer gear
112 — Driving shaft
114 — Differential gear
116,118 — Driving wheel
117,119 — Driving wheel
119 — Case
120 — Planetary gear
121 — Sun gear
122 — Ring wheel
123 — Planetary pinion gear
124 — Planetary carrier
125 — Sun gear shaft
126 — Ring wheel shaft
128 — Power fetch gear
129 — Chain belt
132 — Rota
133 — Stator
134 — Three phase coil
135 — Permanent magnet
139 — Resolver
142 — Rota
143 — Stator
144 — Three phase coil
145 — Permanent magnet
149 — Resolver
150 — Engine
151 — Fuel injection valve
152 — Combustion chamber
154 — Piston
156 — Crankshaft

158 -- Ignitor
160 -- Distributor
162 -- Ignition plug
164 -- Accelerator pedal
164a -- Accelerator pedal position sensor
165 -- Brake pedal
165a -- Brake-pedal position sensor
166 -- Throttle valve
167 -- Throttle-valve position sensor
168 -- Actuator
170 -- EFIECU
172 -- Inlet-pipe negative pressure sensor
174 -- Coolant temperature sensor
176 -- Rotational frequency sensor
178 -- Angle-of-rotation sensor
179 -- Starting switch
180 -- Control unit
182 -- Shift lever
184 -- Shift position sensor
190 -- Control CPU
190 a--RAM
190 b--ROM
191 -- 1st drive circuit
192 -- 2nd drive circuit
194 -- Dc-battery
195,196 -- Current detector
197,198 -- Current detector
199 -- Remaining capacity detector
L1, L2 -- Power-source Rhine
MG1 -- Motor
MG2 -- Motor
Tr1-Tr6 -- Transistor
Tr11-Tr16 -- Transistor

[Translation done.]